

## C L A I M S

1. A cellular radio system including a plurality of base stations respectively belonging to a plurality of base station groups and forming cells having a predetermined diameter, and mobile stations connected to said base stations over CDMA radio channels, each of said base stations using CDMA radio channels of a plurality of radio frequencies allocated to said base station group to which said base station belongs, characterized by comprising:

channel occupancy monitoring means for monitoring channel occupancies of a plurality of radio frequencies allocated to each of said plurality of base stations;

idle hard handoff controlling means for, when a difference between channel occupancies determined by said channel occupancy monitoring means with respect to a plurality of radio frequencies allocated to a single base station becomes a predetermined state, giving a predetermined idle hard handoff instruction for

controlling a radio frequency whose channel occupancy determined by said channel occupancy monitoring means is a predetermined state to a predetermined mobile station of mobile stations that are present in a cell formed by said base station and in a standby state; and

candidate radio frequency setting means, arranged in said mobile station, for, when the idle hard handoff instruction is received, setting a candidate radio

frequency to be used at the time of generating of a next call to the radio frequency designated by the received idle hard handoff instruction.

2. A cellular radio system according to claim 1,  
5 characterized in that said base station transmits the same spreading code with the same phase through each of pilot channels of a plurality of radio frequencies allocated to said base station group to which said base station belongs.

10 3. A cellular radio system according to claim 1, characterized in that said candidate radio frequency setting means sets a candidate radio frequency upon power-off as a candidate radio frequency to be used immediately after power-on.

15 4. A cellular radio system including a plurality of base stations respectively belonging to a plurality of base station groups and forming cells having a predetermined diameter, and mobile stations connected to said base stations over CDMA radio channels, each of  
20 said base stations using CDMA radio channels of a plurality of radio frequencies allocated to said base station group to which said base station belongs, characterized by comprising:

channel occupancy monitoring means for monitoring  
25 channel occupancies of a plurality of radio frequencies allocated to each of said plurality of base stations;

frequency use state notifying means for generating

frequency use state information for notifying said mobile station of a use state of each radio frequency on the basis of the channel occupancies determined by said channel occupancy monitoring means;

5           radio frequency list forming means for receiving the frequency use state information transmitted from said base station under the control of said frequency use state notifying means and forming a radio frequency list in which priority levels are assigned to a  
10           plurality of radio frequencies on the basis of the frequency use state information;

            storage means, arranged in said mobile station, for storing the radio frequency list formed by said radio frequency list forming means even in a power-off  
15           state; and

            initial candidate frequency setting means for performing a search immediately after power-on to check in the order of priority levels whether the radio frequencies indicated by the radio frequency list  
20           stored in said storage means can be used, and setting the first detected radio frequency that can be used as a candidate radio frequency to be used.

25           5. A cellular radio system including a plurality of base stations respectively belonging to a plurality of base station groups and forming cells having a predetermined diameter, and mobile stations connected to said base stations over CDMA radio channels, each of

said base stations using CDMA radio channels of a plurality of radio frequencies allocated to said base station group to which said base station belongs, characterized by comprising:

5           channel occupancy monitoring means for monitoring channel occupancies of a plurality of radio frequencies allocated to each of said plurality of base stations;

10           handoff method determining means for, when said mobile station moves to a new cell formed by another base station belonging to the same base station group to which said base station forming an old cell in which said mobile station has been present belongs, checking, on the basis of the channel occupancy determined by said channel occupancy monitoring means with respect to  
15           said base station forming the new cell, whether the channel occupancy of the radio frequency in the new cell, which has been used by said mobile station in the old cell, is not less than a predetermined value, and determining soft handoff if the channel occupancy of  
20           the radio frequency in the new cell, which has been used by said mobile station in the old cell, is less than predetermined value, and hard handoff if the channel occupancy of the radio frequency in the new cell, which has been used by said mobile station in the  
25           old cell, is not less than predetermined value;

          network-side handoff control means for performing predetermined handoff control associated with said

mobile station by the method determined by said handoff method determining means, and notifying said mobile station of a radio frequency whose channel occupancy in the new cell is not more than a predetermined value,  
 5 when hard handoff is to be performed; and

mobile-station-side handoff control means, arranged in said mobile station, for performing predetermined handoff processing under the control of said network-side handoff control means, when said  
 10 mobile station moves to a cell formed by another base station belonging to the same base station group to which said base station forming a cell in which said mobile station has been present belongs, and performing hard handoff to switch to a radio frequency notified by  
 15 said network-side handoff control means when hard handoff is designated.

6. A base station apparatus belonging to any one of a plurality of base station groups, forming a cell having a predetermined diameter, and connected to a  
 20 mobile station over CDMA radio channels of a plurality of radio frequencies allocated to said base station group, characterized by comprising:

channel occupancy monitoring means for monitoring a channel occupancy of each of a plurality of radio  
 25 frequencies allocated to said self-station; and

idle hard handoff controlling means for, when a difference between channel occupancies determined by

said channel occupancy monitoring means becomes a predetermined state, giving a predetermined idle handoff instruction for controlling a radio frequency whose channel occupancy determined by said channel occupancy monitoring means is in a predetermined state to a predetermined mobile station of mobile stations that are present in a cell formed by said self-station and set in a standby state.

7. A base station apparatus belonging to any one of a plurality of base station groups, forming a cell having a predetermined diameter, and connected to a mobile station over CDMA radio channels of a plurality of radio frequencies allocated to said base station group, characterized by comprising:

channel occupancy monitoring means for monitoring a channel occupancy of each of a plurality of radio frequencies allocated to said self-station; and

frequency use state notifying means for generating and transmitting frequency use state information for notifying said mobile station of a use state of each radio frequency on the basis of the channel occupancies determined by said channel occupancy monitoring means.

8. A base station apparatus belonging to any one of a plurality of base station groups, forming a cell having a predetermined diameter, and connected to a mobile station over CDMA radio channels of a plurality of radio frequencies allocated to said base station

group, characterized by comprising:

channel occupancy monitoring means for monitoring a channel occupancy of each of a plurality of radio frequencies allocated to said self-station; and

5       handoff method determining means for, when said mobile station that has been located in the cell of said self-station moves to a new cell formed by another base station belonging to the same base station group to which said-self station belongs, checking, on the  
10       basis of the channel occupancy determined with respect to said base station forming the new cell, whether the channel occupancy of the radio frequency used by said mobile station in the new cell is not less than a predetermined value, and determining soft handoff if  
15       the channel occupancy of the radio frequency used by said mobile station in the new cell is less than the predetermined value, and hard handoff if the channel occupancy of the radio frequency used by said mobile station in the new cell is not less than the  
20       predetermined value; and

network-side handoff control means for performing predetermined handoff control associated with said mobile station by the method determined by said handoff method determining means, and notifying said mobile  
25       station of a radio frequency whose channel occupancy in the new cell is not more than a predetermined value, when hard handoff is to be performed.

9. A mobile station apparatus used as a mobile station in a cellular radio system including a plurality of base stations respectively belonging to a plurality of base station groups and forming cells having a predetermined diameter, and mobile stations connected to said base stations over CDMA radio channels, each of said base stations using CDMA radio channels of a plurality of radio frequencies allocated to said base station group to which said base station belongs, said cellular radio system further including:

channel occupancy monitoring means for monitoring channel occupancies of a plurality of radio frequencies allocated to each of said plurality of base stations; and

idle hard handoff controlling means for, when a difference between channel occupancies determined by said channel occupancy monitoring means with respect to a plurality of radio frequencies allocated to a single base station becomes a predetermined state, giving a predetermined idle hard handoff instruction for controlling a radio frequency whose channel occupancy determined by said channel occupancy monitoring means is in a predetermined state to a predetermined mobile station of mobile stations that are present in a cell formed by said base station and in a standby state, characterized by comprising:

candidate radio frequency setting means for, when



the idle hard handoff instruction is received, setting a candidate radio frequency to be used at the time of generating of a next call to the radio frequency designated by the received idle hard handoff instruction.

10. A mobile station apparatus used as a mobile station in a cellular radio system including a plurality of base stations respectively belonging to a plurality of base station groups and forming cells having a predetermined diameter, and mobile stations connected to said base stations over CDMA radio channels, each of said base stations using CDMA radio channels of a plurality of radio frequencies allocated to said base station group to which said base station belongs, said cellular radio system further including:

channel occupancy monitoring means for monitoring channel occupancies of a plurality of radio frequencies allocated to each of said plurality of base stations; and

frequency use state notifying means for generating frequency use state information for notifying said mobile station of a use state of each radio frequency on the basis of the channel occupancies determined by said channel occupancy monitoring means, and causing each of said plurality of base stations to transmit the information, characterized by comprising:

radio frequency list forming means for receiving

the frequency use state information transmitted from  
said base station under the control of said frequency  
use state notifying means and forming a radio frequency  
list in which priority levels are assigned to a  
5 plurality of radio frequencies on the basis of the  
frequency use state information;

storage means for storing the radio frequency list  
formed by said radio frequency list forming means even  
in a power-off state; and

10 initial candidate frequency setting means for  
performing a search immediately after power-on to check  
in the order of priority levels whether the radio  
frequencies indicated by the radio frequency list  
stored in said storage means can be used, and setting  
15 the first detected radio frequency that can be used as  
a candidate radio frequency to be used.

11. A mobile station apparatus used as a mobile  
station in a cellular radio system including a  
plurality of base stations respectively belonging to a  
20 plurality of base station groups and forming cells  
having a predetermined diameter, and mobile stations  
connected to said base stations over CDMA radio  
channels, each of said base stations using CDMA radio  
channels of a plurality of radio frequencies allocated  
25 to said base station group to which said base station  
belongs, said cellular radio system further including:

channel occupancy monitoring means for monitoring

channel occupancies of a plurality of radio frequencies allocated to each of said plurality of base stations;

5 handoff method determining means for, when said mobile station moves to a new cell formed by another base station belonging to the same base station group to which said base station forming an old cell in which said mobile station has been present belongs, checking, on the basis of the channel occupancy determined by said channel occupancy monitoring means with respect to  
10 said base station forming the new cell, whether the channel occupancy of the radio frequency in the new cell, which has been used by said mobile station in the old cell, is not less than a predetermined value, and determining soft handoff if the channel occupancy of the radio frequency in the new cell, which has been  
15 used by said mobile station in the old cell, is less than predetermined value, and hard handoff if the channel occupancy of the radio frequency in the new cell, which has been used by said mobile station in the old cell, is not less than predetermined value; and  
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network-side handoff control means for performing predetermined handoff control associated with said mobile station by the method determined by said handoff method determining means, and notifying said mobile  
25 station of a radio frequency whose channel occupancy in the new cell is not more than a predetermined value, when hard handoff is to be performed, characterized by

comprising:

mobile-station-side handoff control means,  
arranged in said mobile station, for performing  
predetermined handoff processing under the control of  
5 said network-side handoff control means, when said  
mobile station moves to a cell formed by another base  
station belonging to the same base station group to  
which said base station forming a cell in which said  
mobile station has been present belongs, and performing  
10 hard handoff to switch to a radio frequency notified by  
said network-side handoff control means when hard  
handoff is designated.

FOOTNOTES